Knowledge of the temporal structure of events in relation to autistic traits and social ability

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Declarations

Conflict of Interest

All authors declare no conflicts of interest.

Ethics Approval

All study procedures were in accordance with the ethical standards of the 1964 Declaration of Helsinki. Approval was obtained from the University of Western Ontario Non-Medical Research Ethics Board (Project #110571).

Informed Consent

Informed consent was obtained from all study participants.

Abstract

Event knowledge, a person's understanding of patterns of activities in the world, is crucial for everyday social interactions. Social communication issues are prominent in autism spectrum disorder, which may be related to atypical event knowledge, such as atypical knowledge of the sequences of activities that comprise the temporal structure of events. Previous research has found that autistic individuals have atypical event knowledge, but research in this area is minimal, particularly regarding autistic individuals' knowledge of the temporal structure of events. Furthermore, no studies have investigated the link between event knowledge and autistic traits in a non-clinical sample. We investigated relationships between event knowledge and autistic traits in individuals from the general population with varying degrees of autistic traits. We predicted that atypical ordering of event activities is related to autistic traits, particularly social communication abilities, but not other clinical traits. In Study 1, atypical ordering of event activities correlated with social ability, but not with most measures of repetitive behaviours and restricted interests. In Study 2, the typicality of activity ordering varied by participants' social ability and the social nature of the events. Relationships were not found between event activity ordering and other clinical traits. These findings suggest a relationship between autistic traits, specifically social abilities, and knowledge of the temporal structure of events in a general population sample.

Keywords

event knowledge, events, temporal structure, autistic traits, social communication, social abilities

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Throughout our lives, we experience a constant stream of situations and events as they continuously occur in the world around us. Some events occur on a daily basis, such as brushing our teeth, whereas others occur less frequently, such as attending a wedding. We take part in many events personally, and also experience events through other people's spoken and written stories, and videos that we watch and hear (see Zacks, 2020 for a review). Through these experiences, we develop and retain knowledge, called *event knowledge*, of the meaningful patterns of activities that constitute a given situation (Elman & McRae, 2019). For example, we know that brushing your teeth involves putting toothpaste on your toothbrush, putting the toothbrush in your mouth, brushing your teeth, gums, and tongue, rinsing your mouth, and so on. People also accrue a great deal of knowledge about events that necessarily are highly social in nature. Attending a wedding can include getting dressed up, driving to the venue, watching the ceremony, congratulating the couple, eating at the reception, and dancing. We each experience the world differently, and there undoubtably are individual differences in event knowledge (Nelson, 1986; Zacks, 2020), even when generally equating for cultural and geographic factors (Swallow & Wang, 2020). People vary in their everyday experiences in terms of first-hand participation, what they hear about, and what they see. Experience differs by geographical location, whether a person lives in a metropolitan versus rural area, people's hobbies and habits, and a number of other factors. All of these factors result in individual differences in knowledge about many events. As part of this, there may be behavioural traits that are associated with less typical event knowledge. In the current studies, we investigated whether individuals' knowledge of the temporal structure of events relates to traits associated with autism spectrum disorder (henceforth referred to as autism), a neurodevelopmental disorder characterized by social

communication differences as well as repetitive behaviours and/or restricted interests. Note that the participants in the studies reported herein were sampled from the general population, rather than from a population of individuals with an autism diagnosis. In taking this approach, we sought to contribute to the literature on individual differences in event knowledge, as well as to provide a basis for potential future research with clinical autistic populations.

Event Knowledge

There are two primary components of event knowledge. The first is the set of people, objects, locations, and other aspects of context that play central roles in events and activities. The second component, on which we focus in this research, is temporal structure, or how events unfold over time. This knowledge has for many years been theorized to be retained in our minds as sequences of activities (scripts; Schank & Abelson, 1977) or sets of related activities, including the people and objects involved in them (schemas; Rumelhart & Ortony, 1977). People use their event knowledge for a variety of purposes, many of which depend on understanding the temporal sequence of activities within events. People use event knowledge to perceive actions (Gao & Scholl, 2011; Johnson et al., 2008), predict ensuing actions and event boundaries (Eisenberg et al., 2018; Radvansky & Zacks, 2017), make inferences about actions and goals (Graesser et al., 1994; Keefe & McDaniel, 1983), guide planning of future behaviour (Zacks & Tversky, 2001), and comprehend language (van der Meer et al., 2002; Metusalem et al., 2012). Importantly, how we learn about events and in turn how we use our knowledge of events involves a basic understanding of others' mental states and intentions, or theory of mind (Baron-Cohen & Swettenham, 1997). This is particularly apparent for social events, such as attending a birthday party. People generally learn about events by experiencing them, and children as young as three years of age can describe what happens during common events (Nelson, 1986). Children

learn through participation, during which they can also use their knowledge of others to guide their behaviours (Nelson, 1986). Children's event representations are also organized around a person's goals, either their own or another person's plans, depending on the age of the child (Nelson, 1986). Individuals make use of theory of mind when understanding and predicting actions as they accrue knowledge about social events, such as understanding why the birthday girl is happy at their birthday party, or why she is eager to open her presents. On the other hand, theory of mind most likely plays a less central role when a child is learning how to brush their teeth, although children can still organize non-social event knowledge around their own goals and the activities involved.

Many of the behaviours that are supported by event knowledge are essential for effective social interaction and communication (for reviews, see Zacks, 2020; Radvansky & Zacks, 2014; also see Nelson, 1981). For instance, we use language to talk about events in a number of ways, including talking to each other about what we have done, what we are doing, and what we are planning to do. We also commonly make inferences based on a person's words, and recognize intentions underlying a person's actions. In addition, we plan our own behaviours to be socially appropriate (hopefully) and predict what other people will do next (whether it is appropriate or not). Event knowledge, including knowledge of the order of activities within events, is foundational to these skills.

Autism Spectrum Disorder and Autistic Traits

Autistic individuals demonstrate differences in several social areas, including turn-taking in conversation, emotion recognition, appropriate social behaviour, and theory of mind (American Psychiatric Association (APA), 2013; Baron-Cohen & Swettenham, 1997). Relatedly, autistic individuals have demonstrated problems in (social) domains that depend on event

knowledge. For instance, it is beneficial to know what may happen next during an event, and event knowledge helps us to recognize common sequences of activities, and to implicitly or explicitly make predictions based on this knowledge. This is apparent in events such as knowing how to prepare ingredients when baking a cake, as well as for more social situations, such as taking part in back-and-forth conversation when discussing a movie you just watched. However, autistic children have difficulties predicting ensuing actions. They have been shown to make fewer accurate predictions about the final action in a video sequence relative to non-autistic children (Zalla et al., 2010). Likewise, autistic children are less able to identify goals in narratives (Goldman, 2008). Understanding what a person will do to achieve their goals allows us to know how to respond to certain behaviours, or how we can act to achieve our own goals. For example, when brushing our teeth, our goal is to have healthy, clean teeth, and when meeting someone new, we may aim to get to know the person (while they get to know us). Autistic children also have been found to experience greater difficulty than non-autistic children in constructing causal (bridging) inferences between two activities in a social event script, such as inferring why a person would go to a swimming pool and then be angry about not being allowed to swim (e.g., the pool was being cleaned or the person left their swimming suit at home; Dennis et al., 2001). Similarly, autistic children have difficulty making inferences based on narrative context (Nuske & Bavin, 2011). Event knowledge allows children and adults to recognize how two actions are related, and in turn assists with social communication, including recognizing reasons behind someone's feelings, such as when someone is angry about not being able to swim at a public swimming pool.

Given that event knowledge is a building block for social communication, it is possible that atypical event knowledge is related to social communication differences characteristic of

autistic individuals. Although causal links have not been established, having less typical event knowledge may also be related to issues with making accurate, generalizable predictions, a tendency thought to be common among autistic individuals (Van de Cruys et al., 2014). Atypical predictive processing, including issues with processing violations of expectations, has been proposed as an explanation of other cognitive tendencies in autistic individuals, including lower theory of mind ability (Van de Cruys et al., 2014; Weismer & Saffran 2022). Social communication differences and differences in theory of mind ability may lead to difficulties with encoding typical event sequences, and the resulting less typical knowledge of events may in turn lead to further differences in social abilities, creating a cyclical relationship.

Previous work indeed suggests that autistic individuals' event knowledge is atypical. When describing events, autistic children mention fewer activities that are important or central to an event than do their non-autistic peers (Volden & Johnston, 1999). Conversely, autistic children often overly focus on details within an event. When asked what normally happens when people go out to a restaurant, autistic children list many food options that someone could eat, instead of including one example or indicating that a meal in general would be eaten (Loth et al., 2008). Similarly, autistic children are less able to identify acts as inappropriate when they are introduced into an event (Volden & Johnston, 1999). Autistic adults and children are more likely to incorrectly judge the frequency at which people generally perform activities, such as indicating that “having dessert” occurs at every meal (Loth et al., 2008; 2010). When asked to recall witnessed or personally experienced events, autistic individuals are more likely to have difficulties than typically developing individuals (for a meta-analysis on episodic memory, see Griffin et al., 2022). In addition, some autistic individuals who scored lower on theory of mind tests displayed atypical knowledge of the temporal order of the activities that comprise an event

(Loth et al., 2008). Research on prospective memory, or the ability to remember to perform planned intentions, suggests that autistic individuals experience problems with remembering planned everyday actions. Autistic participants may have some difficulty with event-based prospective memory (e.g., remembering to take a cake out of the oven when the timer goes off), and even more pronounced difficulties for time-based prospective memory (e.g., remembering to make a phone call at a specific time; for a meta-analysis, see Landsiedel et al., 2017). Similarly, autistic individuals are less likely to spontaneously think about events across time compared to non-autistic individuals (Boucher et al., 2007). Furthermore, autistic individuals may have misperceptions of time in general. For instance, parents report that their autistic children experience trouble with keeping track of time (Poole et al., 2021). In particular, differences are most evident in terms of time perception related to complex stimuli such as events and action planning (for a systematic review, see Casassus et al., 2019).

Beyond a clinically-diagnosed autistic population, traits associated with autism have been found in non-clinical populations, including social communication differences (Sasson et al., 2012). While higher levels of autistic traits have been commonly found in relatives of autistic individuals (referred to as the broad autism phenotype; Bora et al., 2017), autistic traits also are evident to varying degrees in the general population (Stevenson & Hart, 2015). These traits have been found to be stable across time (Robinson et al., 2011) and may be associated with genetic factors (Constantino & Todd, 2004). Of particular interest to the current study is research on temporal perception and thinking about events in relation to autistic traits. Although research indicates higher autistic traits in the general population are associated with enhanced perception of the timing between auditory stimuli (Stewart et al., 2015), individuals with higher autistic traits tend to judge short visual presentations as having longer durations (Xuan et al., 2022).

Additionally, there appears to be a complex relationship between autistic traits and the ability to think about events across time spontaneously. Individuals with higher autistic traits evoke fewer thoughts about past and future events, similar to diagnosed autistic individuals, but only for social events (Orm et al., 2021). However, the link between knowledge of the temporal structure of events and autistic traits, particularly social communication skills, is not well-explored in the general population.

The Current Studies

Knowledge of temporal sequences of activities and events is essential to many aspects of our lives, including social interactions. Autistic individuals demonstrate differences with social communication, and our aim is to understand whether and how event knowledge relates to these kinds of differences. Previous work suggests that autistic individuals have atypical event knowledge, yet there is minimal research exploring the link between knowledge of the temporal structure of events and traits associated with autism, particularly, social communication differences. While studies of autistic traits in the general population may not directly assess the experiences of autistic individuals, our studies may provide insight into individual characteristics contributing to differences in event knowledge. Differences in encoding event knowledge may be due to differences in terms of lifetime experiences, making implicit predictions, social abilities, or the interplay among these factors. While establishing causal relationships with atypical event knowledge is beyond the scope of our current studies, the results may provide a basis for additional investigations on autism symptomatology and experiences with event knowledge in autistic individuals. We investigated how knowledge of the temporal sequence of activities within a wide variety of events relates to autistic traits. Specifically, the current studies

investigated whether the temporal structure of event knowledge relates to traits associated with autism in the general population, particularly lower social communication abilities.

In Study 1, we focused on the temporal structure of events by providing lists of activities to participants and asking them to order the activities. Empirically-derived activity lists were taken from Elman & McRae (2019). We correlated activity ordering with autistic traits. For Study 2, we developed a new set of events that varied in the degree to which they are social, depending on the likelihood/necessity with which other people are involved in the event. There were three levels of social interaction, or ‘socialness’: events with personal interaction (personal interaction is required; e.g., *meeting someone new at school*), events with others (commonly occur in the presence of other people, but personal interaction is not necessarily central; e.g., *spending a day at the beach*), and non-social events (commonly performed by oneself; e.g., *making a sandwich*). Participants listed activities for these events. We investigated differences in activity ordering between individuals with high and low levels of traits (relative to the sample) across the levels of social interaction involved in events. In doing so, we explored whether the social nature of events impacts the relationship between autistic traits and event knowledge.

Study 1 – Ordering of Event Activities

Participants chronologically ordered a list of activities corresponding to an event. They also completed questionnaires to assess levels of autistic traits, including social abilities and repetitive behaviours or restricted interests. We tested whether a higher level of autistic traits would be associated with more atypical ordering of activities within events in the general population. We considered overall level of autistic traits, as well as levels of the traits associated with the two domains of autism: social communication abilities and presence of restricted, repetitive behaviours and interests. We hypothesized that if atypical event knowledge is tied to

lower social abilities in particular, we should find a positive correlation. In contrast, no correlations should be found between activity ordering with events and restricted, repetitive behaviours and interests. Additionally, levels of other clinical traits were assessed to determine whether atypical event knowledge is specific to domains related to autism, or may be a more general clinical issue.

Methods

Participants

One hundred and forty-five participants were recruited for an online study through the University of Western Ontario's Psychology Research Participation Pool in exchange for course credit. Five participants were excluded from analyses because they did not follow the instructions (see Analyses). The final sample of 140 participants ranged in age from 17-22 years ($M = 18$, $SD = 1$), and 100 participants (71%) were female. All participants self-reported that they were English speakers.

Materials and Design

Stimuli consisted of data from Elman & McRae (2019), who asked participants to provide up to 12 steps, or activities, involved in carrying out 81 events. Responses that referred to the same activity but were worded differently across participants were standardized. For example, for the event *taking money out of an ATM*, "get bank card out" and "take bank card out of wallet" were coded as "take out bank card".

We included activities from Elman & McRae (2019) as part of the stimuli for the current Study 1 if at least two participants from Elman & McRae (2019) mentioned the activity, and the activities were not redundant. For instance, for *going to a professional baseball game*, because "go to stadium" and "drive to stadium" were considered redundant, we included only "go to

stadium”. The mean number of activities per event was 28, ranging from 17-39. The 81 events were split into seven lists, each containing 10-12 events. These lists were created to achieve an approximately equivalent number of activities within each list (324-326 total activities per list) so that participants would receive the same amount of work. See Supplementary Information for the seven event lists.

Procedure

The study was conducted online using Qualtrics (Qualtrics Lab Inc., 2019). Participants completed the study on a personal device and in a location of their choosing. Each participant received one list, and there were 20 participants per list. Events were presented randomly one at a time, each on a separate Qualtrics page. Participants were presented with the name of one event and an empty box, along with a randomized list of activities for that event (see Figure 1). Participants were instructed to place the activities in the box “in the order in which you would engage in them for this event.” They were instructed to select activities and to drag and drop them into the empty box. Participants were able to rearrange the activities if they desired. Before moving onto the next page, participants were required to order all of the activities. We also ensured that participants were familiar with, or had known about, the events to some degree and recorded their personal experience (see Supplementary Information for more details).

Figure 1

Items	Writing an email
add subject line	sit down 1
compose email	turn on computer 2
find recipient's email address	open browser 3
send email	go to email program 4
decide on content	log into account 5
attach image	
click compose	
check for errors	
read what you wrote	
add recipient	
log out of account	
click send	
read previous email	

A partially completed example response for the event *writing an email*.

Autistic Trait Questionnaires

Following the ordering task, participants completed self-report questionnaires measuring various traits. For consistency information and example questions of all questionnaires, see Supplementary Information. We used the Autism-spectrum Quotient (AQ), a well-established measure of autistic traits in the broader population, to assess participants' level of autistic traits (Baron-Cohen et al., 2001). The AQ is a 50-item self-report questionnaire that considers five factors associated with autism: social skill, attention switching, attention to detail, communication, and imagination. We used the Multidimensional Social Competence Scale (MSCS), a 77-item self-report questionnaire, to measure a person's social competence (Yager and Iarocci, 2013). The MSCS measures seven domains of social abilities: social motivation,

social inferencing, demonstrating empathic concern or empathy, social knowledge, verbal conversation skills, nonverbal sending skills, and emotion regulation. The Adult Repetitive Behaviour Questionnaire-2 (RBQ-2A) was used to assess the frequency of restricted, repetitive behaviours and insistence on sameness (Leekam et al., 2007; Barrett et al., 2018). The RBQ-2A measures four main factors: repetitive motor movements, rigidity or adherence to routines, restricted interests, and unusual sensory interests.

Additional Clinical Trait Questionnaires

Additional questionnaires assessed a variety of clinically relevant traits to determine whether less typical event knowledge is related specifically to autistic traits, or to more general clinical issues. We used a version of the Spence Children's Anxiety Scale (SCAS; Spence, 1998) adapted for adults to identify forms of anxiety and anxiety disorders, which are characterized by excessive worry or uneasiness (APA, 2013). The SCAS assesses six forms of anxiety: generalized anxiety, panic/agoraphobia, social phobia, obsessive-compulsive disorder, and fears of physical injury. The Adult ADHD Self-Report Scale (ASRS-v1.1; Kessler et al., 2005), an 18-item questionnaire, was used to measure symptoms of attention-deficit/hyperactivity disorder (ADHD), a neurodevelopmental disorder associated with attention difficulties and hyperactive behaviours (APA, 2013). We used the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) to assess symptoms of schizotypal personality disorder, which is characterized by cognitive and perceptual distortions and a pattern of discomfort with close relationships (APA, 2013). The SPQ assesses nine traits of the disorder including: ideas of reference, excessive social anxiety, odd beliefs or magical thinking, unusual perceptual experiences, odd or eccentric behaviour, no close friends, odd speech, constricted affect, and suspiciousness.

Analyses

Five participants were excluded from all analyses because it was clear that they did not complete the task as instructed, and instead randomly ordered activities. These participants ordered activities in ways that made no sense under any circumstances. One event (*going to the dentist to get a cavity filled*) was excluded because of typographical errors in two activities, leaving 80 events.

To investigate how event knowledge differed at an individual participant level, a consensus ordering for each event was created using the ordering data from the current sample. We determined consensus orderings using Borda Count, a voting method that is used to rank voting preferences for candidates in an election (Borda, 1781). Borda Count is likely the oldest and most widely used method for rank aggregation. Borda Count is named after Charles de Borda, who proposed it as a voting method for the French Academy of Sciences in the 18th century, but it was independently discovered even earlier by Nicholas of Cusa in the 15th century and Ramon Llull in the 13th century (McLean, 1990). It is still used in modern settings, including voting for the most valuable player in Major League Baseball (Sanders et al., 2021), rankings of NCAA college teams (Lippman, 2017), student council elections in US colleges (e.g., Harvard University; Berger, 2018), and American football's Heisman trophy ("Heisman Trophy Balloting Info," n. d.). In the case of an event, the first activity ordered by a participant is assigned rank 1, the last activity ordered by a participant is assigned rank N , where N is the number of activities, and all activities in between are ranked accordingly. Points are assigned to each activity relative to the number of activities ranked below it (with the highest ranked activity receiving the most points), and then points are summed across all participants' rankings, using the following equation.

$$B(a) = \sum_{i=1}^k B_i(a)$$

$B_i(a)$ is the number of activities ranked below activity a in a participant's activity list i , and $B(a)$ is the summed total Borda score of an activity across all participants' activity lists (adapted from Dwork et al., 2001). Based on the total Borda score, the activities were then sorted in decreasing order to achieve a consensus ranking (or order).

As an illustrative example, consider a simplified hypothetical set of results in which two participants ordered a subset of activities for *going on a picnic*: “eat food,” “swim,” “play soccer,” and “sit on blanket.” Participant 1 ordered the activities as “play soccer,” “sit on blanket,” “eat food,” and “swim.” In this case, “play soccer” receives 3 points because three activities follow it, whereas “sit on blanket” receives 2 points, “eat food” 1 point, and “swim” 0 points. Imagine that Participant 2 ordered the activities as “swim,” “play soccer,” “sit on blanket,” and “eat food.” In this case, “swim” receives 3 points, “play soccer” 2 points, “sit on blanket” 1 point, and “eat food” 0 points. Based on the summed score of activities, the consensus order would be “play soccer” (5 points), “swim (4 points),” “sit on blanket (3 points)” and “eat food (1 point).”

For each event, we computed each participant's deviation from the consensus order using Spearman footrule distance (Dwork et al., 2001). We averaged each participant's ordering deviation across all events to compute their average deviation from consensus ordering.

We correlated each participant's average ordering deviation with total trait scores and subscale scores on the AQ, MSCS, RBQ-2A, SCAS, ASRS, and SPQ using Pearson correlation. All questionnaire scores were calculated using standard scoring procedures, with two exceptions. The AQ was scored on a four-point Likert scale, with higher scores indicating a higher level of autistic traits (Stevenson & Hart, 2017). The MSCS was reverse scored to match the directionality of all other scales, such that a higher score represents lower social competence.

One participant was removed from analyses involving the AQ total score and subscales because they did not fully complete the AQ, but they were included in all other analyses.

The Benjamini-Hochberg false discovery rate procedure ($Q = .05$) was used to adjust for multiple comparisons on the questionnaire scales used to test our hypothesis that atypical event knowledge is associated with lower social abilities. These subscales include those that represent social domains from the AQ (social skill, communication, and imagination) and all scales from the MSCS. Measures that we predicted would not correlate with atypical event knowledge, including the RBQ-2A and other clinical trait scales (SCAS, ASRS, and SPQ), were not subjected to corrections for multiple comparisons because we predicted that atypical event knowledge is specific to social domains within autistic traits. We chose not to correct for multiple comparisons in this case because it would have increased the probability of achieving the null results we expected across these other traits.

Results

To visualize the participants' activity orderings, heat maps were generated for events (see Figure 2). Participants' ordering of activities varied *within* events, and the extent of variability in participants' ordering differed *across* events. For example, the event *writing an email* had low variability in participants' activity ordering, meaning that participants in general ordered activities in a way similar to each other, and as a result, similar to the consensus order (see Figure 2a). Some participants ordered activities most similar to the consensus order (e.g., Participant 10), while others' ordering was more dissimilar (e.g., Participants 19 and 20). Conversely, the event *cleaning the house* had high variability, meaning that participants' ordering in general was dissimilar to each other and the consensus order (see Figure 2b).

Figure 2

Heat maps constructed for the events a) *writing an email*, which displays less variability in activity ordering, and b) *cleaning the house*, which displays greater variability in activity ordering. Activities are presented on the y-axis according to the consensus order (top to bottom). Participants' ordering for each activity are presented in the columns. The colour coding to designate ranks is presented along the right-hand side of each heat map. A rank of 1 indicates that activity was listed first, and the following activities were ordered accordingly.

Ordering Deviation and Traits

The means, standard deviations, and ranges of the trait questionnaire total scores are presented in Table 1. Participants' average deviation from Borda Count consensus ordering ranged from .10 to .33 (*Mdn* = .16, *IQR* = .05) on a [0,1] scale.¹ There was a significant, positive correlation between ordering deviation and total AQ score (see Table 2 for detailed statistics of all correlations). Ordering deviation was also positively correlated with the social communication subscale of the AQ. Additionally, ordering deviation was positively correlated with the total MSCS score and the social inferencing, empathy, social knowledge, verbal conversation skills, and nonverbal sending skills subscales. Ordering deviation was not significantly correlated with the AQ subscales of social skills and imagination, nor the MSCS subscales of emotion regulation and social motivation, though it should be noted that these relationships trended in the same direction as the other social ability-related scales.

Ordering deviation was not significantly related to the AQ subscales that measure restricted, repetitive behaviours or interests: attention switching and attention to detail. Additionally, it was not significantly correlated with the total RBQ-2A score, nor the RBQ-2A subscales of repetitive motor movements, rigidity, and restricted interests. Ordering deviation was positively correlated with the unusual sensory interests subscale of the RBQ-2A.

The SCAS total score was not significantly related to ordering deviation. Ordering deviation was positively correlated with the fear of physical injury subscale, but not significantly correlated with the remaining SCAS subscales. Ordering deviation was not significantly related to total ASRS score, ASRS subscale scores, total SPQ score, nor SPQ subscale scores. For

¹ Five outliers (ordering deviation greater than 1.5 x *IQR* above the third quartile) were identified. Analyses were conducted both with and without the outliers, and the pattern of results were the same. Outliers were included in the results presented in text.

scatterplots showing correlations between average ordering deviation and composite trait scores, see Figure 3. See Supplementary Information for a description of how composite trait scores were calculated.

Table 1

Descriptive statistics for questionnaire total scores in Study 1 ($N = 140$).

Questionnaire	<i>M</i>	<i>SD</i>	Range
AQ ^a	113.60	12.38	78–154
MSCS	176.74	29.00	98–253
RBQ-2A	35.28	6.77	20–52
SCAS	38.89	16.39	9–85
ASRS	29.02	9.14	10–61
SPQ	26.36	12.89	2–63

Note. AQ = Autism-spectrum Quotient; MSCS = Multidimensional Social Competence Scale; RBQ-2A = Adult Repetitive Behaviours Questionnaire-2; SCAS = Spence Children's Anxiety Scale – Adult Adapted; SPQ = Schizotypal Personality Questionnaire

^a $N = 139$ for AQ only.

Table 2

Correlation results between average deviation from consensus ordering and questionnaire scores ($N = 140$).

Questionnaire	Pearson's r	p	95% CI
AQ Total ^a	.21 *	.01	[.04, .36]
<i>Social Skills^b</i>	.16	.08	[-.01, .32]
<i>Communication^b</i>	.20 *	.04	[.04, .36]
<i>Imagination^b</i>	.11	.19	[-.06, .27]
<i>Attention Switching</i>	.16	.06	[-.01, .32]
<i>Attention to Detail</i>	.02	.80	[-.15, .19]
MSCS Total ^b	.27 *	.01	[.11, .42]
<i>Social Motivation^b</i>	.14	.11	[-.03, .30]
<i>Social Inferencing^b</i>	.25 *	.02	[.09, .40]
<i>Empathic Concern^b</i>	.20 *	.04	[.03, .35]
<i>Social Knowledge^b</i>	.24 *	.02	[.08, .35]
<i>Verbal Conversation Skills^b</i>	.18 *	.05	[.01, .34]
<i>Nonverbal Sending Skills^b</i>	.20 *	.04	[.04, .36]
<i>Emotion Regulation^b</i>	.15	.08	[-.01, .31]
RBQ-2A Total	.10	.26	[-.07, .26]
<i>Repetitive Motor Movements</i>	-.04	.68	[-.20, .13]
<i>Rigidity/Adherence to Routine</i>	.10	.26	[.07, .26]
<i>Restricted Interests</i>	.16	.07	[-.01, .31]
<i>Unusual Sensory Interests</i>	.20 *	.02	[.04, .35]
SCAS Total	.03	.75	[-.14, .19]
<i>Generalized Anxiety</i>	-.03	.73	[-.19, .14]
<i>Panic/Agoraphobia</i>	.07	.41	[-.10, .23]
<i>Social Phobia</i>	-.15	.08	[-.31, .02]
<i>Separation Anxiety</i>	-.02	.86	[-.18, .15]
<i>Obsessive-Compulsive Disorder</i>	.05	.56	[-.12, .21]
<i>Fear of Physical Injury</i>	.24 **	<.01	[.07, .39]
ASRS Total	-.05	.58	[-.21, .12]
<i>Inattention</i>	-.07	.40	[-.23, .10]
<i>Hyperactivity-Impulsivity</i>	<.01	.96	[-.17, .16]

SPQ Total	-.03	.75	[-.19, .14]
<i>Ideas of Reference</i>	-.01	.90	[-.18, .16]
<i>Excessive Social Anxiety</i>	-.07	.39	[-.24, .09]
<i>Odd Beliefs or Magical Thinking</i>	-.01	.93	[-.17, .16]
<i>Unusual Perceptual Experiences</i>	-.01	.88	[-.18, .15]
<i>Odd or Eccentric Behaviour</i>	.07	.40	[-.10, .24]
<i>No Close Friends</i>	.03	.70	[-.13, .20]
<i>Odd Speech</i>	-.11	.20	[-.27, .06]
<i>Constricted Affect</i>	.13	.14	[-.04, .29]
<i>Suspiciousness</i>	-.16	.07	[-.31, .01]

Note. AQ = Autism-spectrum Quotient; MSCS = Multidimensional Social Competence Scale; RBQ-2A = Adult Repetitive Behaviours Questionnaire-2; SCAS = Spence Children's Anxiety Scale – Adult Adapted; SPQ = Schizotypal Personality Questionnaire

* $p < .05$, ** $p < .01$

^a $N = 139$ for AQ total score and AQ subscale scores.

^b indicates that a scale measures social abilities, and have been corrected for multiple comparisons.

Figure 3

Scatterplots corresponding to correlations of average deviation from consensus ordering and composite scores of (a) social ability, (b) restricted/repetitive behaviours, (c) anxiety traits, (d) ADHD traits, and (e) schizotypal traits. * denotes a significant correlation at $p < .05$.

Discussion

To our knowledge, Study 1 is the first to assess the relationship between autistic traits and event knowledge in the general population. Greater deviation from the consensus ordering of event activities was associated with an increase in overall autistic traits, according to the AQ total score. Importantly, lower social abilities, an autistic tendency, were associated with less typical ordering of event activities. Previous findings have shown that lower theory of mind ability in autistic children is associated with temporal ordering violations in their event descriptions (Loth et al., 2008), and our results suggest that issues with temporal ordering of event activities may further be associated with lower social abilities in the general population. Taken together, these results provide support for a relationship between social abilities and event knowledge for a wide assortment of events. Because event knowledge is important for social interactions, if someone retains event information in a form that is less typical, this may affect their social abilities, including communication with others. Concurrently, if someone has lower social communication abilities, they may be less likely to learn and retain typical event information.

Ordering deviation did not significantly correlate with overall restricted/repetitive behaviours, or many of the subscales assessing restricted, repetitive behaviours and interests, although it did correlate with the unusual sensory interests subscale of the RBQ-2A (note that this correlation was not corrected for multiple comparisons, which could have affected this result). Because a person takes in sensory information as part of experiencing events in the world, it is plausible that these domains are related. For instance, if a person consistently focuses on specific sensory aspects of an event while relatively ignoring other aspects, they may retain atypical knowledge of that event. For example, someone might focus on how itchy their dressy

sweater feels when at a cocktail party instead of the rest of the event experience. However, because overall restricted/repetitive behaviour scores and the remainder of the subscale scores did not correlate with ordering deviation, this suggests that individuals with lower social communication abilities have more atypical event knowledge, rather than individuals with a higher rate of repetitive behaviours. It is possible that a person still has a typical understanding of the sequence of activities in events, despite behaving in a particular, repetitive way.

Regarding other clinical traits, ordering deviation did not correlate with overall anxiety, ADHD, or schizotypal traits. No significant correlations were found between ordering deviation and any of the questionnaire subscales measuring these traits, although there was a positive correlation with the SCAS fear of physical injury subscale. This correlation is not one that we expected, and one could predict that it might go in either direction. If you have a fear of physical injury, you might be hypervigilant and thus carefully attend to event structures. On the other hand, you might avoid certain types of events, and as a result not have a rich, typical knowledge base. The latter is more in line with the obtained correlation. With that said, this unexpected correlation analysis was not corrected for multiple comparisons, which raises the probability that it may be a spurious result. Overall, the pattern of correlations suggests that atypical event knowledge, as measured by deviation from consensus ordering of event activities, is specific to higher levels of autistic traits, particularly lower social abilities, rather than being a general clinical issue.

Study 2 – Production of Event Activities

Although there are advantages to providing participants with sets of empirically derived activities as in Study 1, it may also be illuminating to use an activity production task in which individuals are free to generate their own sets of activities. Using this method, we may be able to

gain a better sense of the activities that people consider to be important, beyond a list that was provided to them. In Study 2, we investigated participants' event knowledge by asking them to list their own activities (in chronological order) for a given event.

Additionally, because events vary in their social nature, we created categories of events based on the level of social interaction that typically is involved. Building on the relationship between atypical event knowledge and lower social abilities in Study 1, it is possible that atypical event knowledge is more prominent in social events, in which understanding others' mental states is more likely to be used to understand event structure. We did not manipulate the degree of social interaction during events in Study 1 because the study from which these events were taken did not select events with degree of social interaction in mind (Elman & McRae, 2019). The categorization of events in the current study was agreed upon in discussions with three of the authors.

In sum, Study 2 expands on the results of Study 1 in two ways. First, we asked participants to provide their own ordered lists of activities rather than asking participants to order activity lists that were generated by other people. Second, we used events that we classified into those that require different degrees of social interaction, which allowed us to investigate how level of social interaction inherent to an event influences event knowledge. We again investigated the relationship between activity ordering deviation and social abilities, hypothesizing that individuals with lower social ability would exhibit less typical ordering. Additionally, we predicted that participants with lower social ability would use fewer social words when listing event activities than would participants with higher social ability. We further hypothesized that differences in event descriptions by individuals with lower social ability would be more prominent as the events' level of social interaction increased. Given the results of Study

1, we predicted that any differences in measures would not be present for other levels of clinical traits, including repetitive behaviours/restricted interests in autism. In Study 2, we considered overall levels of trait types rather than individual subscales (note that fear of physical injury was not the focus of this study, and therefore it was not explored separately).

Methods

Participants

One hundred and forty-two participants were recruited for an online study through the University of Western's Psychology Participation Pool (19), e-mail (6), and Amazon Mechanical Turk (117). Mechanical Turk participants were considered high-quality workers (either had a "Master" distinction from Amazon or had completed over 1000 HITs with a 95% or greater approval rating). Participants received course credit (if applicable) or monetary compensation. Nineteen participants were excluded from all analyses (see Analyses). The final sample of 123 participants ranged in age from 17-30 years ($M = 24$, $SD = 3$). Sixty-seven participants (55%) were male, 53 (43%) were female, and three (2%) did not identify on a male/female gender binary system.

Materials and Design

Stimuli consisted of 78 events: 24 from Study 1, 11 from Study 1 with minor rephrasing, and 43 new events. We categorized events based on three levels of social interaction, or 'socialness': Events with Personal Interaction (26 events), Events with Others (28), and Non-Social Events (24). Events with Personal Interaction were ones in which personal interaction is required (e.g., *meeting someone new at school*). Events with Others were those that commonly occur in the presence of other people, but personal interaction is not necessarily central (e.g., *spending a day at the beach*). Non-Social Events were those that are commonly performed by

oneself (e.g., *making a sandwich*). The 78 events were split into six lists, each containing 13 events. Each list included 4 or 5 events of each type. See Supplementary Information for the six event lists.

Procedure

Each participant completed one list using Qualtrics (Qualtrics Lab Inc., 2019) on a personal device and in a location of their choosing. There were at least 20 participants per list, and events were randomly presented on separate Qualtrics pages. Participants were presented with the name of one event and an empty box, and they were asked to “list the activities involved in the event indicated” in chronological order. Participants were not limited in the number of activities that they could list. As in Study 1, we ensured that the events we chose were known about and recorded participants’ personal experience (see Supplementary Information). Following the event listing task, participants completed self-report questionnaires measuring various traits, identical to those used in Study 1, to assess autistic traits and other clinical traits (AQ, MSCS, RBQ-2A, SCAS, ASRS, and SPQ).

Analyses

Nineteen participants were excluded from analyses. Three participants described the reason why an event might happen, rather than the activities involved. Three participants copied information from the internet (e.g., the phrasing matched a WikiHow page on *how to build a snowman*). Thirteen participants were excluded for listing three or fewer steps for a majority of the events, thus providing insufficient data to analyze. For participants who listed three or fewer activities for only one or a few events, their data were excluded for those specific events only.

We paraphrased participants’ responses such that those referring to the same activity but phrased differently were reworded to standardize responses across participants. For example, in

baking a cake, “put cake pan in the oven” and “place the cake in the oven” were considered the same activity and reworded as “put cake in oven”. In contrast, for *taking a test in school*, “ace test” and “pass test” were treated as different activities. Two coders independently paraphrased responses, and subsequently coding was accomplished using continuous discussion and iteratively working through the lists of activities. All analyses used the paraphrased activities, unless otherwise indicated.

To assess participants’ event knowledge, a consensus ordering was created for each event, as in Study 1. However, in Study 1, we were able to use a full list rank aggregation method because the sets of activities were provided, and all participants ranked every activity. For Study 2, because each participant listed some activities shared with others and some not, we used a partial list rank aggregation method (Ammar & Shah, 2012). Although many partial list aggregation methods are possible, to maintain consistency with Study 1, we used the so-called truncated Borda method. Activities that a participant did not mention are given the rank $N + 1$, where N is their last ranked item. Each participant’s deviation from consensus ordering for each event was computed using partial Kendall tau distance. We averaged each participant’s deviation from consensus ordering across all events.

All questionnaires were scored using the Study 1 procedures. One question in the MSCS did not properly display to 20 participants, so imputation was used to replace the missing data based on the participant’s rounded average response to the other items within that subscale. Because Study 2 considered levels of event socialness, composite trait scores were created to allow for comparisons between levels of event socialness and levels of traits using analysis of variance (ANOVA), while considering all of the subscales that measure the given trait. Composite scores of autistic traits were created based on the two diagnostic domains of autism.

A composite social abilities score was calculated using the AQ subscales of communication, social skill, and imagination, along with all of the MSCS subscales. We took the proportion scored out of the maximum possible score for each subscale, minus the minimum score, and averaged these proportions across all subscales using the following equation:

$$\left(\frac{\text{score}_{\text{AQ comm.}} - \min_{\text{AQ comm.}}}{\max_{\text{AQ comm.}} - \min_{\text{AQ comm.}}} + \dots + \frac{\text{score}_{\text{MSCS emo. reg.}} - \min_{\text{MSCS emo. reg.}}}{\max_{\text{MSCS emo. reg.}} - \min_{\text{MSCS emo. reg.}}} \right) / 10$$

Using the same method, a composite restricted/repetitive behaviours score was calculated using the AQ subscales of attention switching and attention to detail, along with the RBQ-2A subscales. Composite scores were also calculated for each of the remaining clinical trait questionnaires separately (anxiety traits, using SCAS subscales; ADHD traits, using ASRS subscales; and schizotypal traits, using SPQ subscales). High and low trait categories were then created for each of the composite scores using a median split relative to the Study 2 sample.

We conducted a mixed 3 (event socialness: within participants) by 2 (trait level: between participants) ANOVA using the social ability composite score to assess whether atypical event knowledge (i.e., ordering deviation) is associated with higher autistic traits, namely lower social abilities. We conducted *a priori* Benjamini-Hochberg-corrected pairwise comparisons between the high and low social ability groups for each level of event socialness. If significant results were found, additional ANOVAs on that measure were conducted for the remaining composite scores (restricted/repetitive behaviours, anxiety, ADHD, and schizotypal traits, respectively) to determine whether the given result was specific to autistic traits. For pairwise comparisons with null results, Bayes factors were calculated to determine the strength of evidence for the null.

The mean percentage of social words produced for each event was assessed using the Linguistic Inquiry and Word Count (LIWC) software, a text analysis program that counts words based on linguistic and psychological categories (Pennebaker et al., 2015). For this analysis, we

used participants' raw responses (not paraphrased). Examples of social words counted by the LIWC include talk, daughter, dad, friend, neighbour, girl, and his (Pennebaker et al., 2015). Although the LIWC counts "you" as a social word, it was excluded because participants used only the generic "you" (e.g., "buy tools you need"). A one-way ANOVA was used to confirm our classification of events into three levels of socialness. While not a direct measure of participants' event knowledge, we also evaluated the mean percentage of social words used *per participant*. We conducted a mixed ANOVA to assess whether the proportion of social words used by each participant differed by level of social ability across event socialness.

Results

Event Socialness and Social Words

The mean percentage of social words used per event differed by event socialness ($F(2, 75) = 41.60, p < .001, \eta^2 = 0.53$). Participants used a higher percentage of social words when describing Events with Personal Interaction ($M = 18.2\%, SD = 8.2\%$) compared to Events with Others ($M = 8.2\%, SD = 5.3\%; t(52) = 6.10, p < .001, d = 1.45$) and Non-Social Events ($M = 3.0\%, SD = 3.3\%; t(48) = 8.92, p < .001, d = 2.39$). Furthermore, a higher percentage of social words were used for Events with Others than for Non-Social Events ($t(50) = 3.11, p = .008, d = 1.15$). These results support our classification of events into levels of socialness.

When considering the mean percentage of social words used by participant (rather than by event), there was not a significant interaction between level of social ability and event socialness ($F(1.55, 187.70) = 0.22, p = .75, \eta_p^2 = 0.02$; Huynh-Feldt corrected; see Figure 4). Pairwise comparisons did not reveal significant differences between high and low social ability groups for any level of event socialness (Events with Personal Interaction: $t(363) = 0.16, p = .99, d = 0.001, BF_{10} = 0.19$; Events with Others: $t(363) = 0.73, p = .99, d = 0.01, BF_{10} = 0.28$; Non-

Social Events: $t(363) = 0.18, p = .91, d = -0.001, BF_{10} = 0.20$). Bayes factors were 0.28 and lower, providing moderate support for the null hypothesis (Jeffreys, in Schönbrodt & Wagenmakers, 2018). There was not a significant main effect of social ability ($F(1, 121) = 0.15, p = .70, \eta_p^2 = 0.001$). There was a significant main effect of event socialness ($F(1.55, 187.70) = 455.08, p < .001, \eta_p^2 = 0.79$; Huynh-Feldt corrected), reflecting the results in the previous paragraph: the percentage of social words used, across both high and low social ability groups, differed depending on the socialness of the event.

Figure 4

Visual representation corresponding to mixed ANOVA (event socialness by social ability) for mean percentage of social words. Error bars are standard error.

Ordering Deviation and Traits

The means, standard deviations, and ranges of trait questionnaire total scores are presented in Table 3. For average ordering deviation, social ability and event socialness significantly interacted ($F(2, 242) = 3.82, p = .02, \eta_p^2 = 0.03$; see Figure 5a). Simple main effects analysis did not reveal significant differences between high and low social ability groups for any

level of event socialness (Events with Personal Interaction: $F(1, 121) = 0.50, p = .84$; Events with Others: $F(1, 121) = 0.004, p = .95$; Non-Social Events: $F(1, 121) = 0.43, p = .76$). However, the interaction appears to have occurred because the difference in ordering deviation between high and low social ability groups changed across levels of event socialness (Difference scores between low and high social ability groups are represented in Figure 5b). There was no main effect of social ability ($F(1, 121) = 0.0004, p = .99, \eta_p^2 < 0.001$). A main effect of event socialness indicated that ordering deviation varied across the three levels of event socialness regardless of high or low social ability group ($F(2, 242) = 35.02, p < .001, \eta_p^2 = 0.22$). Ordering deviation was greater for Events with Others than for Events with Personal Interaction ($t(122) = 5.07, p < .001, d = 0.46$), which was greater than for Non-Social Events ($t(122) = 3.23, p = .004, d = 0.29$), across social ability groups.

Table 3

Descriptive statistics for questionnaire total scores in Study 2 ($N = 123$).

Questionnaire	<i>M</i>	<i>SD</i>	Range
AQ	118.54	18.40	73–168
MSCS	182.02	42.32	88–290
RBQ-2A	30.47	7.72	20–56
SCAS	34.32	20.46	3–101
ASRS	24.27	13.57	0–57
SPQ	26.54	16.18	0–70

Figure 5

Visual representation corresponding to mixed ANOVA (event socialness by social ability) for (a) average deviation from consensus ordering, and (b) difference scores between high and low social ability groups in average deviation from consensus ordering. Error bars are standard error.

To determine if the significant interaction was specific to social ability, additional ANOVAs were calculated for all other clinical traits. There was no interaction in any of these analyses. There was also no main effect of trait level, but there was a significant main effect of event socialness. These results suggest that the significant interaction found for average ordering deviation was specific to level of social ability. See Supplementary Information for detailed ANOVA results for these other clinical traits (Table SI2) and visual representations (Figure SI1).

Discussion

We investigated the relationship between traits associated with autism, specifically social abilities, and event knowledge in the general population using an activity production task. We found a significant interaction between social ability group and event socialness level, suggesting that there is a relationship between a person's social ability and the social nature of an event for how people order event activities. Specifically, the difference in ordering deviation between high

and low social ability groups appears to change across levels of event socialness (Figure 5). However, simple main effects analyses did not reveal any significant differences in ordering deviation between the high and low social ability groups within each level of event socialness. As such, conclusions cannot be drawn about ordering deviation differences between social ability groups within *particular* levels of event socialness. Nevertheless, the interaction was specific to social ability as we predicted, and was not found between high and low levels of other clinical traits.

It is possible that individuals with low social ability may find social events to be less predictable and take part in these events less often, contributing to less typical knowledge of the order of activities within these events, compared to events with fewer social aspects. Furthermore, it is possible that a person's event knowledge may fundamentally differ depending on the socialness of the event and the degree to which a person enjoys or avoids social interaction. Learning and knowledge depend on experience, and the presence (or absence) of social elements in an event might influence the frequency with which a person takes part in that type of event.

Surprisingly, no differences were found for the proportion of social words used by participants with high compared to low social ability across all levels of event socialness. This contrasted with our hypothesis that individuals with lower social ability would use fewer social words across all events, with the difference being most prominent in Events with Personal Interaction, the most social event type. Although prior research indicates that autistic individuals make fewer references to characters in narratives (Arnold et al., 2009), our production task was more constrained, and our sample was not from an autistic population. Recent research suggests that as autistic children age, they use person-referential language more often during naturalistic

interactions (Barokova & Tager-Flusberg, 2020). In the current study, participants were older (young adults) and the events they described occur in real life. It is therefore conceivable that these older individuals from the general population would refer to others when describing events, in contrast to our prediction.

General Discussion

These are the first studies to examine the relationships among the temporal structure of event knowledge, autistic traits, and social abilities in the general population. We used a large number and wide variety of events to explore these relationships. In Study 1, deviation from consensus ordering of activities significantly correlated with overall autistic traits (as measured by the AQ), overall social competency (as measured by the MSCS), and most subscale measures of social communication abilities (Table 2). Previous research has shown that autistic children with lower theory of mind commit more temporal ordering violations in their event descriptions (Loth et al., 2008). Similarly, autistic individuals have been shown to have issues with time in general, particularly for complex stimuli, such as remembering to perform everyday event activities (Casassus et al., 2019). Our results build on previous evidence that non-autistic individuals with higher autistic traits may think about events over time differently (Orm et al., 2021), although the specific link between temporal ordering of event activities and autistic traits had not yet been studied in the general population. The current study demonstrates that temporal ordering issues in event knowledge may be more broadly related to a range of lower social abilities, and extend to the general population beyond a clinically diagnosed autistic group.

Study 2 showed an interaction between the social nature of events and social ability on participants' average ordering deviation (Figure 5a). Across levels of event socialness, the difference in ordering deviation between high and low social ability groups changed (Figure 5b).

Notably, our findings demonstrate a novel relationship among social ability, the social nature of an event, and a person's knowledge of events' temporal structure. A potential explanation is that the social nature of an event may differentially influence the knowledge that a person has of the event due to a person's level of social ability, including their theory of mind competency. A person's social ability, their desire or hesitance to engage in social interactions, and the degree to which an event centres on social interaction may influence a person's knowledge of how events tend to unfold over time.

Furthermore, some individuals may be less likely to put themselves in a social situation that is less predictable (at least for them) than other non-social situations. Consequently, they may accrue less extensive knowledge regarding the typical order of activities of an event, partly due to less experience (fewer learning opportunities), and thus order these social events' activities in a less typical way. This may be particularly true if individuals with higher autistic traits are more likely to have trouble with making predictions or realizing when expectations are violated, tendencies that have been seen in individuals with an autism diagnosis (Van de Cruz et al., 2014). Further to this idea, individuals with lower social abilities may choose to experience non-social events to a much higher degree and accrue sufficient (or even exceptional) representations of typical non-social event sequences. Similarly, this was proposed by Orm et al. (2021) as a potential explanation for why adults in the general population with higher autistic traits are less likely to spontaneously think about past and future events when presented with socially dynamic situations, but this difference is not apparent for non-social situations. Finally, it is possible that relationships are circular in that less typical event knowledge, lower predictability, and lower comfort in social situations may further affect social communication abilities.

Limitations

Event knowledge is vast and rich, including the ways in which it can be acquired. In the current studies, we did not consider societal or cultural contexts that may affect a person's event knowledge and how they might think about sequences of activities. Additionally, we chose to form hypotheses focused on the social communication domain of autism, rather than the restricted, repetitive behaviours and interests domain. However, it would make sense that if a person has a restricted (atypical) way of behaving during an event, they may have an atypical representation of that event. Relationships between event knowledge and this domain may be better detectable in a diagnosed, clinical sample. Moreover, while questionnaires such as the AQ can provide reliable information on levels of traits, they are not able to fully capture individual experiences in a way that qualitative measures would. Furthermore, if we had compared a diagnosed autistic group of individuals to a non-autistic group with low autistic traits, we may have been able to find a more definitive pattern of results when comparing ordering deviation across different types of social and non-social events in Study 2. Future studies should consider how both domains of autism diagnostic characteristics relate to event knowledge in diagnosed autistic samples.

The phrasing of our task may possibly have influenced responses. In Study 1, participants may have been more likely to order the activities in their specific way of performing an event (we asked participants to order activities in the order “*you*” would do them, rather than what a typical person may do). However, this likely would not have made much of a difference, because participants were constrained by the activities that were given to them. In addition, this may have been a feature rather than a bug of Study 1; we asked all participants how you would do things. For Study 2, in which participants came up with their own activities, the instructions were more

neutral (we asked them to list the activities involved in the event in chronological order), and did not refer to what the participant specifically might do. As a result, we believe that the study more likely tapped into event knowledge as we intended, rather than personal preference of how to perform the event. Lastly, each event's typical, or consensus, ordering of activities was derived using data from within each study's sample. If consensus orderings were created using data from an independent sample, such as a sample with low levels of autistic traits, differences in ordering deviation between groups may have been more evident in Study 2. These issues could be explored in future studies.

Conclusion

In sum, a relationship between ordering of event activities and social abilities was evident in both studies. The current studies provide novel evidence that higher levels of some traits related to autism, particularly lower social abilities, are associated with less typical knowledge of the temporal structure of events in the general population, and that this relationship depends to some extent on the social nature of events.

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Supplementary Information for Study 1Event ListsList 1

going on a picnic
baking an apple pie
writing an email
taking the driver's license test
buying a car
going to the emergency room
voting in a national election
getting ready in the morning for work or school
building a sandcastle
taking a cruise for vacation
planting a tree
going to a national holiday celebration

List 2

cleaning the house
attending a professional football game
washing the dishes
giving a business presentation
celebrating a wedding anniversary
police raid on a mafia house
building a house
getting yourself ready for bed
building a fence
washing the car
getting a book from the library
mailing a gift

List 3

making a sandwich
going to a concert
hosting a barbecue
building a snowman
getting a child ready for bed
planting a vegetable garden

working out at the gym
making fruit salad
going to the zoo
filling a car at the gas/petrol station
going to the symphony
serving nice wine to guests

List 4

attending a professional baseball game
riding the city bus from home to work or school
going through a fast food drive-thru
going to your high school graduation
gambling at a casino
playing a round of golf
driving across the country
doing the laundry
dressing up for a fancy event
attending a funeral
going for a night out at the club
dining at a nice restaurant

List 5

going grocery shopping
going to a child's birthday party
changing a flat tire
taking money out of an ATM
making coffee
attending a wedding
parking the car downtown
going to the dentist to get a cavity filled
going camping
going to a fast food restaurant
getting a manicure
making a large breakfast on the weekend

List 6

getting a speeding ticket
going sailing
going to a movie
going to a fancy cocktail party
shopping for clothes
taking a shower
taking a college exam
taking your dog to the vet
going to the beach
getting a haircut
baking a cake

List 7

going to the doctor for a checkup
interviewing for a job
being in a car accident
mowing the lawn
going trick-or-treating at Halloween
filming a movie scene
having a nice family portrait taken
catching a flight at the airport
going on a first date
painting a room

Familiarity and Personal Experience Ratings

For each event, participants rated how familiar they were with the given event on a scale from 1 (*not familiar at all*) to 7 (*very familiar*). They were informed that familiarity refers to the degree to which they have heard of the event or have knowledge of it, and this knowledge may be from family and friends telling stories, TV, movies, games, or reading. Participants were also asked to rate their direct personal experience with the event (how much they have participated in the event), on a scale from 1 (*have never done it personally*) to 7 (*have done it many times*).

Mean rated familiarity for each event ranged from 2.15 to 6.75 ($M = 4.79$, $SD = 1.27$), while mean rated event personal experience ranged from 1.15 to 6.85 ($M = 3.85$, $SD = 1.72$). These results suggest that we had chosen events that, on average, were moderately to well known about and experienced.

Questionnaire Reliability Information and Item Examples

Cronbach's alpha (α) for the Autism-spectrum Quotient is acceptable at .79 (Stevenson & Hart, 2015). Internal consistency varies among the subscales: social skills ($\alpha = .75$), attention switching ($\alpha = .61$), attention to detail ($\alpha = .56$), communication ($\alpha = .62$), and imagination ($\alpha = .46$). Examples questions include *"I frequently find that I don't know how to keep a conversation going"* and *"I prefer to do things the same way over and over again."*

There is good internal consistency for the total Multidimensional Social Competence Scale score ($\alpha = .89$), as well as the subscales, with α ranging from .74 to .86 (Trevisan et al., 2018). Example items include, *"I smile appropriately in social situations (e.g., if given a compliment, greeting someone, in response to someone smiling at me)"* and *"I disagree with people without fighting or arguing."*

The total Adult Repetitive Behaviour Questionnaire-2 score has a good internal consistency of .83 (Barrett et al., 2015). Example items include *"Do you have a special interest in the feel of different surfaces?"* and *"Do you like to arrange items in rows or patterns?"*

Internal consistency of the total Spence Children's Anxiety Scale (children's version) is excellent at .92, while α for the different forms of anxiety ranges from .60 to .82 (Spence, 1998). The adult adaption includes several phrasing changes that refer to work (in addition to school) to be more adult-oriented (item 10, *"I worry that I will do badly at my school or job"*; item 16, *"I have trouble going to work or school in the mornings because I feel nervous or afraid"*; item 35, *"I feel afraid if I have to talk in front of my class or co-workers"*).

Internal consistency for the Adult ADHD Self-Report Scale is good ($\alpha = .89$; Adler et al., 2006). Example items include, *"How often do you have trouble wrapping up the final details of a*

project, once the challenging parts are done?” and “How often are you distracted by activity or noise around you?”

Internal consistency for the total Schizotypal Personality Questionnaire score is excellent at .91, while α ranges from .66 to .81 for the subscales (Raine, 1991). Questions include “*Are your thoughts sometimes so strong that you can almost hear them?*” and “*People sometimes comment on my unusual mannerisms and habits.*”

Additional references not included in main text:

Adler, L. A., Spencer, T., Faraone, S. V., Kessler, R. C., Howes, M. J., Biederman, J., & Secnik, K. (2006). Validity of pilot adult ADHD Self-Report Scale (ASRS) to rate adult ADHD symptoms. *Annals of Clinical Psychiatry, 18*(3), 145–148.
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Trevisan, D. A., Tafreshi, D., Slaney, K. L., Yager, J., & Iarocci, G. (2018). A psychometric evaluation of the Multidimensional Social Competence Scale (MSCS) for young adults. *PLoS ONE, 13*(11), 1–19. <https://doi.org/10.1371/journal.pone.0206800>

Table SI1

Correlation results between questionnaire total scores and subscale scores ($N = 140$).

Questionnaire	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
1. AQ Total	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.09	<.001	<.001	<.001	.56	<.001	<.001	.01	<.001	.007	<.001	<.001	.001	<.001	.002	.40	.11	.77	<.001	.02	<.001	.31	.01	<.001	<.001	<.001	<.001	.03	
2. Social Skills	.84***	–	<.001	<.001	<.001	.43	<.001	<.001	<.001	<.001	.03	.91	<.001	.01	.25	.41	.05	.19	.70	<.001	.04	<.001	<.001	.05	.007	.02	.80	.23	.05	<.001	.22	<.001	.60	.18	.03	<.001	.05	<.001	.08	
3. Communication	.73***	.62***	–	.001	<.001	.89	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.15	.90	.14	.06	.06	<.001	.003	<.001	<.001	.002	.01	<.001	.03	.01	.25	<.001	.19	<.001	.92	.07	.001	<.001	<.001	<.001	.23	
4. Imagination	.50***	.30***	.27**	–	.04	.15	<.001	<.001	<.001	<.001	<.001	.07	<.001	.03	.32	.79	.22	.61	.79	.25	.48	.20	.05	.40	.45	.06	.96	.82	.85	.04	.78	.02	.17	.14	.64	.02	.38	<.001	.71	
5. Attention Switching	.69***	.56***	.43***	.17*	–	.83	<.001	<.001	<.001	.05	.38	.18	<.001	<.001	<.001	.54	<.001	.01	.16	<.001	<.001	<.001	<.001	<.001	.004	.08	.004	.92	<.001	.11	<.001	.1	.58	<.001	<.001	.003	<.001	.19		
6. Attention to Detail	.33***	.07	-.01	-.12	.02	–	.67	.07	.11	.02	.75	.38	.07	.07	<.001	.05	.04	<.001	<.001	.11	.66	<.001	.60	.39	.006	.46	.58	.17	.54	.003	.005	.13	.001	.007	.004	.21	.20	.18	.04	
7. MSCS Total	.60***	.50***	.65***	.40***	.40***	-.04	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.04	.68	.03	.05	.01	.001	.62	<.001	.03	.05	.003	<.001	<.001	<.001	.004	<.001	.13	<.001	.51	.06	<.001	<.001	<.001	<.001	.14	
8. Social Motivation	.75***	.77***	.62***	.29***	.48***	.15	.67***	–	<.001	<.001	<.001	.36	<.001	.002	.22	.55	.04	.17	.19	.002	.31	<.001	<.001	.03	.02	.02	.49	.04	.26	<.001	.42	<.001	.73	.09	.004	<.001	.08	<.001	.08	
9. Social Inferencing	.46***	.41***	.49***	.33***	.39***	-.14	.76***	.42***	–	<.001	<.001	<.001	<.001	<.001	.02	.33	.02	.11	.11	.003	.69	.004	.001	.19	.004	<.001	<.001	<.001	.008	<.001	.57	.001	.92	.44	.01	<.001	<.001	<.001	.49	
10. Empathic Concern	.34***	.37***	.42***	.33***	.17	-.19*	.76***	.46***	.47***	–	<.001	<.001	<.001	<.001	.16	.11	.61	.19	.56	.59	.01	.30	.43	.43	.51	.10	.84	.98	.73	.34	.61	.80	.39	.71	.98	.003	.91	<.001	.89	
11. Social Knowledge	.32***	.19*	.44***	.29***	.07	.03	.76***	.35***	.57***	.60***	–	<.001	<.001	<.001	.60	.87	.61	.32	.03	.56	.22	.04	.32	.39	.65	.02	.04	.27	.008	.04	.80	.48	.44	.15	.05	.03	.14	<.001	.92	
12. Verbal Communication Skills	.14	-.01	.32***	.16	.11	-.07	.57***	.08	.44***	.29***	.44***	–	.001	<.001	<.001	.08	.16	.78	.03	.001	.03	.34	.05	.74	.008	.01	.02	<.001	.007	<.001	.02	.05	.92	.16	.16	.002	.79	<.001	.30	.78
13. Nonverbal Sending Skills	.53***	.39***	.47***	.37***	.29***	.16	.77***	.56***	.48***	.58***	.55***	.22**	–	<.001	.01	.28	.03	.02	.03	.08	.48	<.001	.33	.61	.05	.01	.02	.01	.12	<.001	.16	<.001	.29	.04	.005	<.001	.04	<.001	.02	
14. Emotion Regulation	.31***	.22*	.37***	.19*	.39***	-.16	.62***	.26**	.42***	.31***	.30***	.45***	.34***	–	.001	.25	<.001	.02	.01	<.001	<.001	<.001	<.001	.004	<.001	<.001	<.001	<.001	<.001	<.001	.004	<.001	.51	.05	.006	.004	.003	<.001	.02	
15. RBQ-2A Total	.30***	.10	.12	.08	.28***	.34***	.17*	.10	.19*	-.12	.04	.15	.21*	.27**	–	<.001	<.001	<.001	<.001	<.001	<.001	.002	.006	.06	<.001	.01	<.001	.003	<.001	<.001	.001	.003	<.001	<.001	.006	<.001	<.001	<.001	<.001	
16. Repetitive Motor Movements	.05	-.07	-.01	.02	.05	.17*	.04	-.05	.08	-.14	-.01	.12	.09	.10	.75***	–	.02	<.001	<.001	.001	.002	.05	.02	.11	<.001	.17	<.001	.004	<.001	<.001	.04	.05	.03	.001	<.001	.11	<.001	.02	.005	
17. Rigidity/Adherence to Routine	.29***	.17*	.13	.10	.33***	.17*	.18*	.17*	.19*	-.04	.04	.02	.18*	.30***	.68***	.20*	–	<.001	<.001	<.001	.02	.03	.02	.15	<.001	.02	.09	.19	.09	.002	.006	.003	.18	.001	.49	.02	.56	.03	.004	
18. Restricted Interests	.31***	.11	.16	.04	.21*	.42***	.16	.12	.13	-.11	.08	.19*	.19*	.20*	.80***	.42***	.44***	–	<.001	.004	.05	.007	.26	.30	<.001	.14	.003	.04	<.001	<.001	<.001	.04	<.001	<.001	.02	<.001	<.001	.009		
19. Unusual Sensory Interests	.21*	.03	.16	.02	.12	.31***	.21*	.11	.14	-.05	.19*	.27**	.18*	.21*	.65***	.39***	.31***	.74***	–	.05	.13	.04	.69	.59	<.001	.21	<.001	.02	<.001	<.001	.003	.17	.05	.002	<.001	.06	<.001	.003	.15	
20. SCAS Total	.41***	.30***	.36***	.10	.40***	.14	.27**	.26**	.25**	-.05	.05	.19*	.15	.45***	.36***	.27**	.28***	.24**	.17*	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.005	<.001	<.001	<.001	<.001	<.001		
21. Generalized Anxiety	.23**	.17*	.25***	-.06	.32***	.04	.04	.09	.03	-.21*	-.10	.08	-.06	.36***	.29***	.25**	.19*	.17	.13	.83***	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.19	.001	.005	.003	<.001	.03	.002	
22. Panic/Agoraphobia	.45***	.30***	.38***	.11	.28***	.31***	.34***	.31***	.24**	.09	.18*	.17*	.28***	.35***	.26**	.17*	.19*	.23**	.17*	.85***	.66***	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
23. Social Phobia	.40***	.36***	.32***	.17	.44***	-.04	.19*	.28***	.27**	-.07	-.09	.03	.08	.37***	.23**	.19*	.20*	.10	.03	.74***	.59***	.48***	–	<.001	<.001	<.001	<.001	<.001	.08	<.001	<.001	.27	.003	.04	<.001	<.001	<.001	<.001		
24. Separation Anxiety	.27**	.16	.26**	.07	.38***	.07	.17*	.18*	.11	-.07	.07	.22**	.04	.24**	.16	.14	.12	.09	.05	.75***	.54***	.57***	.48***	–	<.001	<.001	.002	.01	.002	<.001	<.001	.06	.007	.02	.01	<.001	.06	.008		
25. Obsessive-Compulsive Disorder	.35***	.23**	.21*	.06	.34***	.23**	.25**	.20*	.24**	-.06	.04	.22*	.16	.41***	.52***	.38***	.39***	.41***	.29***	.80***	.58***	.64***	.49***	.52***	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
26. Fear of Physical Injury	.26**	.19*	.32***	.16	.24**	-.06	.33***	.20*	.30***	.14	.20*	.20*	.22**	.36***	.21*	.12	.19*	.13	.11	.65***	.39***	.54***	.37***	.52***	.44***	–	<.001	<.001	.004	<.001	.006	<.001	.10	.04	.002	.001	<.001	.003	<.001	
27. ASRS Total	.07	-.02	.18*	.004	.15	-.05	.31***	.06	.32***	-.02	.17*	.37***	.20*	.45***	.37***	.41***	.14	.25**	.32***	.42***	.33***	.33***	.29***	.27**	.40***	.34***	–	<.001	<.001	<.001	.009	.01	.29	.01	<.001	.01	<.001	<.001	.009	
28. Inattention	.14	.10	.21*	.02	.24**	-.12	.29***	.17*	.32***	-.003	.09	.23**	.22*	.42***	.25**	.24**	.11	.17*	.19*	.39***	.28***	.29***	.35***	.21*	.34***	.35***	.90***	–	<.001	<.001	.02	.003	.58	.09	<.001	.003	<.001	<.001	.04	
29. Hyperactivity-Impulsivity	-.03	-.17*	.10	-.02	.008	.05	.24**	-.10	.22**	-.03	.22**	.44***	.13	.37***	.42***	.50***	.14	.29***	.39***	.35***	.29***	.29***	.15	.26**	.37***	.25**	.85***	.54***	–	<.001	.03	.20	.16	.006	<.001	.19	<.001	.02	.01	
30. SPQ Total	.50***	.39***	.40***	.17*	.32***	.25**	.39***	.41***	.29***	.08	.17*	.19*	.41***	.34***	.46***	.33***	.26**	.44***	.34***	.60***	.40***	.55***	.50***	.36***	.59***	.35***	.40***	.38***	.32***	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
31. Ideas of Reference	.20*	.10	.11	.02	.14	.24**	.13	.07	.05	-.04	.02	.17	.12	.25**	.33***	.18*	.23**	.34***	.25**	.44***	.29***	.37***	.33***	.28***	.49***	.23**	.22**	.20*	.19*	.72***	–	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
32. Excessive Social Anxiety	.53***	.52***	.41***	.20*	.36***	.13	.30***	.46***	.27**	.02	.06	-.008	.31***	.31***	.27**	.17*	.25**	.18*	.12	.56***	.45***	.46***	.67***	.37***	.37***	.28***	.21*	.25**	.11	.73***	.41***	–	.05	<.001	.001	<.001	<.001	<.001	<.001	
33. Odd Beliefs or Magical Thinking	.09	-.05	.008	.12	-.09	.27***	.06	.03	.008	-.07	.07	.12	.09	.06	.25**	.18*	.11	.28***	.17*	.24**	.11	.28***	.09	.16	.31***	.14	.09	.05	.12	.52***	.46***	.16	–	<.001	<.001	.04	.03	.02	<.001	
34. Unusual Perceptual Experiences	.22**	.12	.15	.13	.05	.23**	.16	.14	.07	-.03	.12	.12	.17*	.17*	.38***	.27**	.27**	.33***	.25**	.40***	.27**	.40***	.25**	.23**	.49***	.17*	.21*	.14	.23**	.70***	.55***	.45***	.52***	–	<.001	<.001	<.001	<.001	<.001	
35. Odd or Eccentric Behaviour	.33***	.18*	.27**	.04	.30***	.24**	.28***	.24**	.21*	.001	.17*	.25**	.24**	.23**	.44***	.38***	.06	.51***	.42***	.36***	.23**	.36***	.17*	.20*	.41***	.27**	.42***	.39***	.35***	.68***	.41***	.27**	.39***	.36***	–	<.001	<.001	<.001	<.001	
36. No Close Friends	.58***	.57***	.51***	.19*	.40***	.11	.48***	.63***	.34***	.25**	.19*	.02	.56***	.24**	.23**	.14	.20*	.20*	.16	.43***	.25**	.44***	.43***	.21*	.38***	.27**	.22*	.25**	.11	.70***	.28***	.59***	.17*	.29***	.42***	–	<.001	<.001	<.001	
37. Odd Speech	.29***	.17	.3																																					

Composite Score Equation for Figure 3

Composite scores of autistic traits were created based on the two separate domains that are considered for clinical diagnosis: social abilities and restricted/repetitive behaviours. A composite social abilities score was calculated using the AQ subscales of communication, social skill, and imagination, along with all of the MSCS subscales. We took the proportion scored out of the maximum possible score for each subscale, minus the minimum score, and averaged these proportions across all subscales using the following equation:

$$\left(\frac{\text{score}_{\text{AQ comm.}} - \min_{\text{AQ comm.}}}{\max_{\text{AQ comm.}} - \min_{\text{AQ comm.}}} + \dots + \frac{\text{score}_{\text{MSCS emo. reg.}} - \min_{\text{MSCS emo. reg.}}}{\max_{\text{MSCS emo. reg.}} - \min_{\text{MSCS emo. reg.}}} \right) / 10$$

Using the same method, a composite restricted/repetitive behaviours score was calculated based on the remaining AQ subscales along with all of the RBQ-2A subscales. Composite scores were calculated for each of the remaining clinical trait questionnaires separately (anxiety traits, using SCAS subscales; ADHD traits, using ASRS subscales; and schizotypal traits, using SPQ subscales).

Supplementary Information for Study 2Event ListsList 1

answering the front door
checking into a hotel
negotiating the price of a used car
working on a group project
playing a board game with your family
going to a movie with friends
attending a funeral
celebrating on Christmas morning
spending a day at the beach
brushing your teeth
building a snowman
spending a rainy day inside
planting a vegetable garden

List 2

working a shift as a server in a fancy restaurant
picking teams at recess
calling the police about an emergency
talking with a counsellor
having a tea party
attending a wedding
playing tag
catching a flight at the airport
taking a driving test
getting ready for school or work
baking an apple pie
filling up a car at the gas station
playing a video game

List 3

going to the doctor's office for a check-up
ordering a pizza over the phone
getting a haircut
listening to someone talk about their problems
playing bingo
going to an amusement park
playing in a soccer game
going on a picnic
going to a school dance

taking money out of an ATM
baking a cake
cleaning the house
doing your homework

List 4

asking someone out on a date
meeting someone new at school
taking a piano lesson
interviewing for a job
going bowling
going to the emergency room
volunteering at a nursing home
going to a friend's birthday party
going swimming at a public pool
borrowing a book from the library
building a sandcastle
decorating your room
being in a car accident

List 5

introducing your girlfriend or boyfriend to your parents
asking for help to find milk in a store
meeting a celebrity
sharing a toy
going to the zoo
going to a fancy restaurant
organizing a potluck dinner
going on a school field trip
going trick-or-treating on Halloween
taking your dog for a walk
taking a test in school
working out at the gym
making a sandwich

List 6

being called to the principal's office
firing someone
teaching someone how to play Tic Tac Toe
going on a first date
going to a fast food restaurant
singing in a school recital
riding the city bus to school or work
going shopping with your parents

going to a national holiday celebration
changing a flat tire
taking a shower
buying a gift for your mom
making a large breakfast on the weekend

Familiarity and Personal Experience Ratings

Mean rated event familiarity ranged from 2.45 to 6.95 ($M = 5.12$, $SD = 1.19$). Mean personal experience for each event ranged from 1.22 to 7 ($M = 4.42$, $SD = 1.59$). These results suggest that the events, on average, were moderately known about and experienced.

Figure SI1

Visual representation corresponding to mixed ANOVA results (event socialness by trait level) for (a) restricted/repetitive behaviours, (b) anxiety traits, (c) ADHD traits, and (d) schizotypal traits. *Note.* Error bars are standard error

Table SI2

Results for consensus ordering deviation ANOVAs for clinical traits other than social ability

Effect	<i>F</i>	<i>df</i>	<i>p</i>	η_p^2
Restricted/Repetitive Behaviours				
Event Socialness	34.77	(2, 242)	<.001	.22
Trait Level	0.08	(1, 121)	.78	.001
Event Socialness x Trait Level	0.94	(2, 242)	.39	.01
Anxiety Traits				
Event Socialness	34.54	(2, 242)	<.001	.22
Trait Level	0.82	(1, 121)	.37	.01
Event Socialness x Trait Level	1.58	(2, 242)	.21	.01
ADHD Traits				
Event Socialness	34.57	(2, 242)	<.001	.22
Trait Level	0.08	(1, 121)	.78	.001
Event Socialness x Trait Level	1.09	(2, 242)	.33	.01
Schizotypal Traits				
Event Socialness	34.20	(2, 242)	<.001	.22
Trait Level	0.01	(1, 121)	.92	.000
Event Socialness x Trait Level	0.68	(2, 242)	.51	.01